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AND

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We herewith present to our readers the first communication of Mr. Klein, whom we before announced as a regular contributor to the Railroad Journal.

We have before given to our readers, ample details of the St. Petersburg and Zarskoe Selo railroad, and we are now enabled to complete the statistics to the commencement of the present year. There are many interesting deductions to be drawn from these details; and the completeness of the information, and its methodical arrangement, may serve as a model in preparing the statistics of our own railroads.

For the American Railroad Journal and Mechanics' Magazine.

ST. PETERSBURG AND ZARSKOE—SELO RAILROAD.—ITS OPERATIONS IN THE YEAR 1839.

There are few railroads in Europe the progress and success of which have been watched with so mnch interest as that of the St. Petersburg and Zarskoe Selo railroad. Although one of the shortest lines of improvements of this kind, the peculiar circumstances under which it was projected and commenced; the manner of construction itself, and finally its important influence upon the whole system of railroads to be introduced sooner or latter in the vast Russian empire, were motives enough to engage the attention of all friends of internal improvements.

A report of the late Chavalier de Gerstner,* on this railroad, was published in English three years ago; in this report an account was given of the location of the road, its grades, and plan of construction, and the progress it had made up to the winter of 1837. In the summar following, the remainder of the works were finished, and the railway opened to Zarskoe

* See first Russian Railroad from St Petersburg to Zarskoe Selo and Pawlowsk; &c translated from the German. St Petersburg, 1837.

Selo, a distance of 15 miles, on the 30th of October 1837. The continuation to Pawlowsk, 2 miles further, though completed soon after, was not opened until May 1838. Since that time the whole line has been in operation, without interruption through all seasons of the year, and to the general satisfaction of the public, the trains have daily been running over the road with the greatest precision and regularity; thus proving what, until lately was thought problematic—that railways may be constructed and used to as much advantage in Russia as in any other part of the globe.

The following short statistics of the Zarskoe Selo railroad will spare the reference to the Chev de Gerstner's report. Totol length of the railroad 25½ versts, or 17 English miles. No curves, except at the St. Petersburg terminus. Total ascent from St. Petersburg to Pawlowsk 87 feet, average rise, 5 feet to a mile, steepest grade 10½ feet to a mile. Track single; width of the same: six feet clear; superstructure: wooden cross ties, upon a stone foundation, supporting heavy T rails of 65 lbs per yard, fastened in chairs every 3 feet.

Number of locomotive engines on the road, six; diameter of cylinders, 14 inches; stroke 18 inches; diameter of driving wheels, 6 feet; weight 14 tons.

From the report lately made by the directors of the company to the shareholders at their last annual meeting, the following statements have been carefully extracted, and will, with the conclusions drawn from them give a clear insight into the operation and management of the road during the year 1839.

1. *Cost of construction.*—The total cost of the road up to the end of 1839 was 1,503,823.50 rubles in silver, and consists in the following principle items:

Construction of the road itself,	676,450.47	S. R.
Buildings of every kind,	301,421.68	—
Locomotives, cars, &c.,	259,050.89	—
Engineering, and all other incident expenses,	266,900.46	—
Total expenditure,	1,503,823.50	—

or 228,740 liv. st., or 1,110,000 dollars. Of this amount 1,000,000 rubles were paid in by the shareholders, and 500,000 rubles were loaned to the company, by the government, at 5 per cent. interest and one per cent sinking fund.

The cost of the road per mile, is therefere 13,455 liv. st., or 65,300 dollars.

2. *Number of passengers; receipts.*—The following table contains the number of passengers conveyed monthly over the road between the different places; as also the receipts from passengers, as well as from other sources:

MONTHTS. 1839	NUMBER OF PASSENGERS CONVEYED.				RECEIPTS FOR THE WHOLE YEAR.		
	Between St. Petersburg and Zarskoe—Selo.	Between St Petersburg and Pawlo'sk	Way passengers	Total	From passengers	From other sources	Total
					DOLLARS	DOLL'RS	DOLLARS
January,	25,055	6,744	5,060	36,859	10,280	510	10,790
February,	23,441	5,538	4,231	33,210	9,818	347	10,165
March,	25,601	5,418	4,344	35,363	10,543	295	10,768
April,	29.608	9,585	5,171	44,364	13,531	155	13,686
May,	66,013	7,154	20,980	94,147	24,583	265	24,848
June,	68,848	2,103	25,334	96,285	22,799	530	23,329
July,	65,608	15,50	28,264	95,422	22,596	347	22,943
August,	67,033	——	25,574	92,607	22,874	482	23.356
September	56,429	84	14,744	71,257	18,154	395	18,549
October,	50,681	22	8,745	59,448	14,632	2635	17,267
November	30,707	3,025	4,778	38.510	10,499	452	10,951
December	22,480	1,632	4,042	28,154	7,987	690	8,677
Whole year,	531,504	42,855	151,267	725,626	188,296	7,033	195,329

From this statement it appears, that the total number of passengers which travelled on the Zarskoe Selo railroad, in 1839, was 725,626; if reduced to the whole length of the road, we find the number equal to, 521,882 through passengers.

The population of St. Petersburg is now	470,000
" of Zarskoe Selo, - -	11,400
" of Pawlowsk, - - -	4,100
Total population on the line of the railroad,	485,500 or

36,382 less than the number of passengers which travelled over the whole road during one year. If the number of through passengers (521,882) be compared with the total passage money, it gives at an average per passenger for 17 miles, 49 copeks silver, or 36 cents; or per passenger per mile only $2\frac{1}{7}$ cents.

If the total receipts for the year be divided by the length of the road in miles (17) it gives 11,490 dollars gross income per mile of road, per year, which compared with the cost of the road per mile (65,300 dollars) shows that the gross receipts per year amounted to $17\frac{6}{10}$ *per cent on the cost of construction.*

3. *Travel of locomotive engines. Speed.*—The following shows the monthly returns of the trips made by the locomotive engines upon the road:

MONTHS. 1839	Number of trips with passengers	Duration of trip betwe'n St Petersburg, and Zarskoe Selo		Average speed	Numbes of miles travelled by all locomotives	Average rec't per mile of travel
		shortest	average			
		MINUTES	MINUTES	MILES		
January,	213	30	42.9	21	5,333	202 cents
February,	301	30	42.5	21	5,233	194 —
March,	310	32	40.6	22	5,167	208 —
April,	327	30	40	$22\frac{1}{2}$	5,667	241 —
May,	528	25	43.7	$20\frac{1}{2}$	9,433	263 —
June,	609	31	39	23	10,200	229 —
July,	609	30	38.2	$23\frac{1}{2}$	10,150	226 —
August,	578	26	39.3	23	9,617	243 —
September	480	25	39.5	23	8,167	227 —
October,	442	27	39.8	$22\frac{1}{2}$	7 583	228 —
November	293	31	40.6	22	5,000	219 —
December,	301	33	42.2	$21\frac{1}{2}$	5,033	172 —
12 m'nths	5,091	25	40.8	22	86,583	226 —

There have been made during the year, 5091 trips over the whole road, equal to 7 trips each way per day; the average time spent on a trip between St. Petersburg and Zarskoe Selo (15 miles,) including one stoppage haif way, was 40.8 minutes, which gives an average speed of 22 miles per hour; the shortest time spent on one trip was 25 minutes, corresponding to a speed of 36 miles per hour.

The number of miles, run by six locomotives during 12 months were 86,583, being at an average 14,430 miles by each engine. One of the engines, the "Elephant," has run only 2,567 miles, which leaves for each of the remainder, 16,803 miles, at an average.

The number of carriages used for the 5091 trips (counting a carriage once for each trip) was 27,333; and the number of through possengers carried therein, as before stated, 521,882; this makes at an average, per trip, $5\frac{1}{3}$ carriages, and $102\frac{1}{2}$ passengers, or per carriage 19 passengers. The carriages are of 4 different classes, all fourwheeled, and contain each from 24 to 60 seats for passengers.

In the last column of the above table is contained the average receipts per mile of travel of the locomotives, with their trains in every month of the year. It demonstrates the fact that the income per mile of travel is always greatest, when the traffic on the road is large, as then the number of passengers per trip will average more, while with a small traffic the trains will frequently be half empty, and the receipts per mile proportionally small.

4. *Current Expenses, Net Revenue.* The following were the expenses of managing thc railroad during the year ending 31st December, 1839, divided under the different heads.

a) Maintenance of Road and buildings:

	$	$
Maintenance of the road itself, ground rent, bridges, turnouts, road crossings. &c., -	11,490	
watchmen and police, - - - - -	8,806	
Maintenance of buildings, insurance, heating, and lighting, . - - - -	10,356	
		30,652

b) Transportation Account:

Motive power, repairs of engines, engine and firemen's wages, pumping water, fuel, oil, hemp, &c. - - - - - -	34,440	
Repairs of cars, oil, &c., - - - - -	7,452	
Wages, and clothing of conductors, agents, -	9,719	
		51,611

c) General Expenses:

Wages of superintendents and officers, rent, police, discount, stationary, &c. - - -	17,281	
Pensions and indemnities to persons injured upon the road, - - - - - - -	1,867	
		19,148

d) Expenses for Entertainments:

Music, illuminations, fireworks, - -	26,297	
Other incidental expenses, - - -	6,778	
		33,075
Total Expenditure, - - -		$134,486

The total gross receipts having been 195,329 dollars, the net income amounted to 60,845 dollars, or to 31 per cent. of the gross receipts, or to $5\frac{1}{2}$ per cent. on the capital of construction.

To have a clearer view of the expenses connected with the railroad itself, the latter sum of 33,075 dollars, expended for the entertainment of the public ought not to be taken into account. It has been ascertained that the income derived by these extra expenses is only sufficient to cover these expenses, and, therefore, has no influence upon the net revenue. To be enabled, therefore, better to compare the results of the Zarskoe Selo rail- with those of other roads, the sum of 33,075 dollars must be deducted both from the gross receipts and current expeuses: we then have:

Current Expenses:	*dolls.*		*cts.*
For maintenance of way, &c.	30,652,	being per mile of travel	35.4
" transportation account,	51,611	- - -	59.5
" general expenses, -	19,148	" " "	22.1
Nett income, - - -	60,843	" " "	70.0
Gross receipts	**162,254**	" " "	**187**

The nett proceeds are now 37 per cent of the gross revenue; the expenses 63 per cent. The expenses per mile of travel of a locommotive with a train of cars are 117 cents, and are obtained by dividing the total current expenses with the number of miles travelled by all engines during the whole year. If we compare the expenses per mile of travel (117 cents) with the average number of through passengers in a train ($102\frac{1}{2}$) or also the total current expenses (\$101,411) with the number of passengers reduced to one mile, which is $521,882 \times 17 = 8,871,994$ we find the expense per passenger per mile, equal to 1.14 cents.

It may be of interest to consider more minutely some of the items of expenditure, we then see the expenses of maintaining and watching the road are equal to 1194 dollars per mile of railroad per year. This amount is very considerable, and the cause of it to be found in the great number of hands employed constantly along the line for the purpose both of watching the road and keeping the rails in the proper level.

The expenses for motive power comprise the following items:

Repairs of engines	\$4884	per mile of travel,			5.64	cents.
Pumping water, -	775	"	"	"	0.90	—
Fuel (coke) - -	20,081	"	"	"	23.19	—
Oil and tallow, hemp,	1,804	"	"	"	2.08	—
Engineers and firemen	6896	"	"	"	7.96	—
Total, - -	\$34,440	"	"	"	39.77	—

The motive power costs forty cents for every mile the engines run, only the seventh part of this expense is for repairs of the engines. The fuel alone costs 23 cents per mile. Upon the American railroads with moderate grades, the engines drawing passenger trains, consume at an average, 1 cord or 128 cubic feet of hard wood for every 40 miles they run. The price of the wood varies from 2 to 6 dollars, including sawing, splitting, &c. In St. Petersburg, the price of birch wood will be about $4\frac{1}{2}$ dollars per cord of 128 cubic feet; and if we again allow 40 miles for one cord, we have as the expense of fuel per mile of travel, $\frac{450}{40}$ cents, $= 11\frac{1}{4}$ cents, or one half of the present expense for coke. The reason why wood is not used as fuel for the engines upon the St. Petersburg railroad, is the want of an effective spark catcher, by which the throwing out of sparks through the chimney might be entirely prevented.

In regard to the whole operation of the road, the results may be considered as very satisfactory. Although constructed at an expense of \$63,000 per mile, and passengers are carried at such low rates, the railroad nevertheless yields an annual interest of $5\frac{1}{2}$ per cent. on the capital invested.

As the company has to pay 6 per cent. on the loans, as interest and sinking fund, the dividend paid to the shareholders for the year 1839 was only 4 per cent.

L. Klein.

London, June, 1840.

To the Editors of the Railroad Journal and Mechanics' Magazine.

REMARKS UPON THE EXPLOSION OF THE LOCOMOTIVE UPON THE HARLEM RAILROAD,—July 4th, 1839.

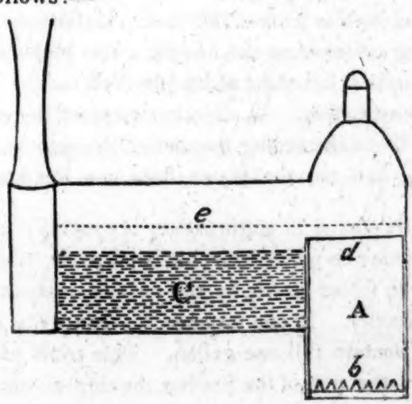
Supposing the readers of the Journal may be desirous of learning more of the particulars relative to the explosion of the locomotive upon the Harlem railroad, on the 4th of July 1839, than appeared at the time in the public prints, I give them to you as near as I could gather them on the ground soon after the accident occurred, together with my views of the cause.

The engine was nearly new, constructed in most respects on the most approved plan, for a six wheeled engine, and had run but little over a year. It is not reasonable to suppose therefore, that the accident was owing *altogether* to a defect in the engine. At the time of the explosion, I was not far distant, being on my way to take my seat in the cars which were to be conveyed to Harlem, by the engine in question,—of course as but a few minutes had elapsed between the explosion and my arrival on the ground, the fragments of the engine &c. occupied very nearly the several positions in-into which they were thrown by the explosion.

At the time of the accident there was no train attached. The train from Harlem had just been brought down, and passed on with horses to the City Hall, and the *up* train had not arrived, though not far distant.

In reversing the direction of the engine for the purpose of returning to Harlem, which was done by passing it on to the eastermost track by means of a turn out,—the forward or truck wheels, owing to a defect in the *switch*, got off from the track. The superintendent with the assistance of some others, including the Engineer, set immediately at work to replace the engine on the track, and when they had nearly accomplished their object, the explosion took place. killing instantly the engineer, tearing and mangling his body in a most horrid manner, and injuring more or less severely several others.

On examining the boiler, I discovered that the roof of the fire-box was completely blown out, carrying with it the grate and bottom of the fire-box, with all the fuel it contained. To render the explanation the more clear I present a sketch as follows:—



A is the fire-box, *b* the grate, C the tubes, *d* the roof of the fire-box, and *e* the level of the water in the boiler when filled.

In the explosion the iron plate forming the roof *d* of the fire-box, gave way, *downward* carrying with it the grate, fuel, &c. The reaction was so great as to cause the engine to plunge suddenly forward, the rear part being forced up obliquely; the engine was thrown upon its side, separating it of course from the tender.

The injury to the engine was produced mainly by the force with which it was thrown over, breaking the shaft of the driving wheels, the journals of two or three of the others, the cylinders, and most of the working gear. The boiler did not appear to be much injured, save in the parts mentioned; and the reason of the Engineer being so badly mangled must have beeu owing to his standing in such a position as to receive most of the contents of the fire-box.

The cause of the explosion I suppose to have been simply this: more time was probably occupied in getting the engine on to the track than was imagined. In the mean while the fire was not extinguished, and the engine not being in motion, the force pump was not in operation, the water fell in the boiler, and became so low as to expose or uncover the roof of the fire-box, which soon becoming heated gave way under the force of the steam from above.

I have seen no published explanation of the cause, or of the appearance of the boiler and engine, after the explosion; but I feel confident that I am not far from correct in the view I have taken.

It has always appeared to me that the roof of the fire-box of a locomotive, was the part most liable to give way under a diminution of water in the boiler. It is higher than the tubes, and would be first exposed. It receives also the direct vertical action of the heat, and when once uncovered, must become red hot in a very few moments; and being a *horizontal* plate three feet square, or thereabouts, would, unless made very thick and strong, and supported by iron ribs, soon give way under pressure.

The roof of the fire-box in question was supported in this manner, there being about seven bars of $1\frac{1}{2}$ by two inch wrought iron extending across and firmly riveted to the plate of the roof. Unfortunately these bars, instead of extending *quite* across and having a firm bearing upon the upright portions of the fire-box, fell short about $\frac{3}{4}$ths of an inch. This certainly was a defect in the construction. In all other respects, the engine appeared to be well made. Notwithstanding this defect, the roof would not probably have given way, had not the water been too low and the iron become heated.

That this occurs oftener in engines than is generally imagined, I do not doubt. Engines may be pointed out on several roads, where the roofs of the fire-box have been forced down by the superincumbent pressure so as to form quite a concavity. In one instance, the concavity has been observed large enough to contain full one gallon. This could only, I think, have been produced by the roof of the fire-box, having at same time been unco-

vered sufficiently long, to have become somewhat heated, and thereby weakened. It is, perhaps, almost needless to state that should they be permitted to remain in this situation long, while the fires are burning briskly, an explosion would be the inevitable consequence.

The above is, I believe, the second instance of an explosion of a locomotive, where the consequences were at all serious; the first having occurred about a year previous on the Rainhill plane of the Liverpool and Manchester railroad. Within the past year a third instance is stated to have occurred on some one of the roads in the U. S., the particulars of which, if made public, have never met my eye.

FULTON.

NOTICE OF SOME EXAGGERATED STATEMENTS IN REGARD TO THE VACUUM MAINTAINED IN THE CONDENSERS OF THE BRITISH QUEEN, AND OTHER ENGLISH STEAMERS.—HALL'S CONDENSERS.

Many of our readers no doubt were surprised, as we ourselves were at the statement that the guage attached to the condensers of the British Queen, indicated a steady vacuum of $30\frac{1}{2}$ inches, during the trip out in April last. When it is recollected that the average pressure of the atmosphere, supports at the level of the sea but 30 inches of mercury, the inquiry very naturally suggests itself,--how can a vacuum be obtained which is not only perfect, but carries with it a minus pressure or subtractive force of $\frac{1}{4}$ of a pound per square inch?

In endeavoring to solve this question, we fortunately found in the same number of the Mechanic's Magazine, with the log of the "British Queen" a drawing of "Bedwell's patent steam engine barometer," by which this extraordinary vacuum was registered. A mere inspection of the drawing is sufficient to explain a little more than the surplus above a perfect vacuum, and in the condensers themselves we may perchance find a cause for further reduction. Were this not the case, we should have in Hall's condensers a more complete instrument than the most highly finished air pump—*notwithstanding* the *pressure of aqueous vapor*--a manifest absurdity.

In the first place "Bedwell's barometer" is no more than an ordinary air pressure gauge—with this exception, that instead of the open leg of the cyphon, is found a bulb open at top, and which contains the mercury as it descends in the closed end. An exact coincidence in the two limbs—indicatting a perfect vacuum—is marked three inches, and above this the scale is laid off by inches decreasing to about 25. Now it is evident that the assumption of 31 inches is gratuitous, and likely to cause erroneous estimates to be made.

A much safer and better mode of graduating would be to commence with zero for a perfect vacuum, and to number the inches 1, 2, 3, &c., upwards, which would give at once the resistance of the air and vapor included in the condenser. Thus in the case above mentioned, instead of $30\frac{1}{2}$ inches

vacuum, (a round about way of denoting it, to say the least) we should have an atmosphere supporting ½ an inch or a pressure of ¼ of a pound per square inch to be deducted from the effective pressure.

From some remarks in a communication on this subject in the Mechanics' Magazine, we are led to suppose that the instrument in question could not have been in order and the slightest portion of vapor or air in the closed end would of course tend to vitiate all its indications.

It may also be observed that there is an exaggeration in stating that the guage stood *steadily* at 30½ inches as on the very day the certificate to this effect wss signed, and for several days preceeding the vaccum, as given in the published log, was not so great. In fact 30½ inches are recorded only on five days out of the fourteen.

Another objection urged by several writers, and one which we consider as having some weight, is, that the condenser on Hall's plan, is exceedingly complicated, in its passages, and that the vacuum indicated by the gauge, exists at a point comparatively speaking, quite remote, from the cylinder, and is therefore, no more an indication of the useful vacuum, than the pressure in the boiler is a measure of the useful pressure in the cylinder. When it is remembered that in each of the condensers of the "British Queen," the steam passes through *seven miles* of ½ inch pipe, it is easy to see that an instantaneous effect cannot be produced throughout the apparatus.

We have been favorably impressed with the advantages offered by Hall's condensers, but we must confess that we fear that they cost as much as they are worth, if not a little more. The immensity of this apparatus in the "British Queen," quite startled us, and we could not upon reflection, reconcile this with our ideas of economy in size and weight. The question is between the increased vacuum (?), the clean boilers, and consequent saving of fuel on the one side, and the increased cost and weight, and the loss of room on the other.

We give a table of the dimensions of the machinery of the "British Queen," and "India," by which it seems that the space occupied by this apparatus is nearly equal to that of a good sized steam engine itself.

	British Queen, 500 *h. p.*	*India* 350 *h. p.*
Diameter of Cylinder,	77½ inches	63 inches
Hall's condensers, each,	77½ inches square and 12 feet high	63 do. exact shape and size of cylinder. 7 feet 1 inch high
Miles of half inch pipes in the two condensers	14*	9
No. of joints in ditto,	14,000*	9,000
Two extra force pumps to supply the condensers,	area 22½ by 17½ and 3 ft. 8 stroke	area 18 in. diameter stroke 3 ft. 10 in.
Revolutions,	14½ and 18 when light	not given
Vacuum,	30½	29½
Stroke	7 feet	5 feet 9

* No mistake, I assure you—fourteen miles of pipes, and fourteen thousand joints. Nice employment for the engineers to keep joints tight when they have nothing else to do; and no fear of derangement from expansion and contraction, which at 15 revolutions a minute takes place alternately every second!

We are much obliged to our correspondent Fulton, for the sensible description of a disaster which excited much attention, and yet has never, so far as we have known, been properly explained. How much better would it be on the occurrence of this or other accidents of the kind, for some intelligent person to examine immediately into the matter, than to indulge in the newspaper twaddle usual on such occasions.

Coach wheel retarder.—Full trial has now been made of the valuable invention of R. W. Gearrad, Jun. Esq. for retarding,(not locking) the wheels of carriages when going down hill. Mr. Dangerfield, coach proprietor, having had it applied first to one of his Southampton coaches, and afterwards to the Shrewsbury coach, and in both cases with the greatest success. The principle of the invention, is pressure, so applied to the nave of the wheel, as to retard its motion, or at will of the coachman, stop it altogether. The advantages of the invention are, that the power may be applied at the discretion of the coachman.

Frauds in soap.—With regard to silica and clay soap, the experiments which have been hitherto made are not sufficiently numerous to give the requisite information; but as neither the silica nor the clay contributes anything to the detergent qualities of the soap, but merely increase its weight, all such additions should be prohibited by government. Suppose a pound of good soap to cost 6d., and that another soap containing 20 per cent of silicia or clay, is sold at 4⅘d., the two will be exactly the same value, for four pounds of the good soap will go as far as five pounds of the adulterated soap. If the manufacturer charges 5d. for the pound of the adulterated article, he overreaches his customers to the extent of a farthing per pound. If this apparent cheapness have a tendency to increase the sale of soap, it operates as a premium to induce manufacturers in general to adulterate the article. The great extent to which the trade of Great Britain has reached was originally founded on the goodness of the article manufactured; the present rage for cheapness has an universal tendency to adulterate, every article exposed for sale; and unless it is counteracted by a vigilant government, it must terminate in the destruction of the foreign trade of the country. The soap made for transportation is always of inferior quality; hence the monopoly of the French soap-makers, who supply Italy, Spain, and South America with all the soap required by those extensive countries. If silica soap be permttied to be made, it ought to be charged according to its specific gravity, allowing it to contain 20 per cent of silica, as the maker supposes it to do. Hence its specific gravity in the liquid state ought to be 1.3191. Hence a pound of it will have the bulk of 21.016 cubic inches; or it ought to pay one-fourth more duty than common yellow saop. In what is called clay soap, the clay is not at all combined with the alkali, no soap is formed with it; and its action is merely mechanical; in fact it diminishes the power of the soap with which it is mixed in proportion to the quantity. The motives for mixing clay with soap are too obvious and too well understood, to require any comment.—*Report of Commissioners of Excise.*

The opening of the Taunton and New Bedford railroad took place July 1st, and went off Admirably. The governor of Massachusetts, and a large number of citizens attended. The Boston Adv. says:

On their return one of the trains ran over the N. Bedford and Taunton road, 20 miles, in 38 minutes and another in 35. The Taunton branch of 11 miles was passed by the returning party in 22 minutes, and the portion of the Providence road, 24 miles, which makes a part of the route to New Bedford, was passed in 49 minutes.

For the American Railroad Journal and Mechanics' Magazine.

A SYNOPSIS OF BIONOLOGY. BY OLIVER SMITH.

ZOOLOGY.

Of the *animals* the tisue contains a full proportion of Nitrogen.

- Of the *Articulated* animals the tisue is very muscular.
  - Of the *Vertebrates*, or the animals which have bones, the tisue is very fibrous.
    - Bicordates
      - Of the Mazons the tisue is carnate.
        - *Antrope* or Anthropos, man
        - *Geomazons*, the terester mazons
        - *Hydromazons*, the aquatic ones
      - Of the *Ornithies*, or fowls the tisue is suigenery, though it is somewhat carnate about the neck.
    - Pulmonates
      - Of the Reptiles the tisue is carnate.
        - Panopierpons
          - Poderpons
            - *Testudinies*, turtles
            - *Saurocopies*, ichthiosaurus
            - *Saurics*, lizards
          - Lepiderpons
            - *Saurophies*, Ophisaurus
            - *Ophies*, proper serpents
        - Gymnerpons
          - *Pedonerpies*, frogs
          - *Branchiaterpies*, sirens
    - Of the Ichthies the tisue is suigenery.
      - Ichtheosties
        - *Malacopters*, salmon
        - *Acanthopters*, perches
      - Icthechonders or *Chonderopters*, sharks
  - Of the *Entomies* the tisue is much indurated externally; while it is celular and full of fluids within.
    - Entomobranchiates.
      - *Entomapodes*, leeches
      - Entomoplies
        - *Crustates*, crabs
        - *Entomostracas*, horse-foot
    - Entomotracheates
      - Octopodes
        - *Entomopsiles*, spiders
        - *Entomateles*, ticks
      - Orthotracheates
        - Hexapodes
          - Entomopters
            - Tessaropters
              - Stegopters
                - Maxilates.
                  - *Stegomacters*, coleopters or horn bug.
                  - *Stegodermas*, cock-roaches
                  - *Stegodomos*, grass-hoppers
                - Haustelates
                  - *Stegomipters*, bed-bugs
                  - *Stegomopters*, cicadas
              - Hyperopters
                - Maxilates.
                  - *Trichopters*, larvas in water
                  - *Nomoneuropters*, libelulas
                  - *Terrebrifers*, tenthredoes
                  - *Aculeifers*, bees
                - Maxilohaustelates or *Leipodopters*, butterflies
            - Entomodipters
              - *Strephopters*, kirbies,
              - *Librators*, flies
          - *Hexapodapters*, fleas
        - *Myriapodes*, centipedes
- Of the *Moluscate* animals the tisue is soft, and many of them have a calcian habitation.
  - *Zoacephalics* or Chitseheadless animals. nomics.
    - *Hetropodes*, carinaries
    - *Cephalopodes*, cuttle-fish
    - *Gastropodes*, slugs
    - *Conchophors*, snails
  - Nor ..cacapitates. Tunickecapitates.
    - *Cirropodes*, balanies
    - *Valvifers*, clams
    - *Spermazoas*, resembling seeds — Tunicates of authors — Small & floating
    - *Polyzoas*, associated but not compound
    - *Siphonics*, holothurias
    - Discates
      - *Dermecheinies*, star-fish
      - *Medusas*, Portuguese man of war
    - Elminthies
      - *Exolminthies*, worms living on the exterior of other animals.
      - *Endolminthies*, worms living in the interior of other animals.

Crinoidophors, *Stomanthics*, *Fistulifers*, *Rupifers*, *Fruticulifers*, *Spongifers*, *Plumulifers*, *Vaginifers*, *Podostomas*, *Hetrozoas*	*Animalculas*	*Yeastas* or common yeast; *Fungues*, *Algas*, *Lichens*
The Zoophites exhibit both an animal and vegetable character.	The Infusorties appear in warm water which contains animal or vegetable matter.	Phytanomics (see Botany, upon the next page.)

The Biomycetes are entirely celular and contain only a moderate portion of nitrogen.

BIONOLOGY—(see upon the next page)

A SYNOPSIS OF BIONOLOGY.

(Continued.)

The Vascular plants have spiral vessels within them; and their tissue assumes, to a greater or less extent the form of ligneous fibre.

- The Flowering plants bear flowers and exhibit considerable ligneous fibre
  - The Exogenous plants increase by addition to their outside; they consist much of ligneous fibre; their seeds are dicotyledinous and their leaves for the most part are annually deciduous.
    - Of the Spermendytics the ovary is normal, inclosing the seeds at their incipience at least.
      - Ecorolates :
        - Ecalycates :
          - *Spadexogenas*, pepper
          - *Spathexogenas*, podostema
          - *Ovarinaments*, birch
          - *Nomacalycates*, all the rest
        - Calycates :
          - *Nucemoschifers*, nutmeg
          - *Juglandifers*, walnut
          - *Depatocarpics*, oak
          - *Artocarpics*, fig
          - *Spermagonies*, buck-wheat
          - *Corticaromas*. sassafras
          - *Nomastephanics*, all the rest
      - Corolates :
        - Petalates.
          - *Orangifers*, orange
          - *Pomifers*, apples
          - *Plumbifers*, plum
          - *Vinifers*, grapes
          - *Rizophors*, see natural order
          - *Parenchymates*, cactus
          - *Umbelifers*, dill
          - *Leguminifers*, beans
          - *Siliquifers*, mustard
          - *Rosates*, rose
          - *Magnolians*, white wood
          - *Malvates*, mallows
          - *Bombacates*, bombax
          - *Linins*, flax
          - *Nympheans*, pond lily
          - *Violates*, violets
          - *Nomexogenas*, all the rest
        - Of the Corolintegers, the petals of the coral are connected together & many of them are herban and frutican.
          - *Peponifers*, punkin
          - *Composites*, sun-flower
          - *Campanulates*, add convolvulates
          - *Stylidates*, natural order
          - *Stellates*, madder
          - *Normalabiates*, all the irregulars
          - *Nomolostephanics*, all the rest.
    - Of the Spermagymnics the ovary which is a mere scale or contracted leaf never encloses the seeds; and the texture of their ligneous fibre is somewhat peculiar.
      - *Pinins*,
      - *Juniperins*,
      - *Zamians*,
  - The Endogenous plants increase by additions to their interior parts. They are seldom much ligenous compared with the higher grades of plants, and their seeds are monocotyledinous
    - *Spadicoidates*, palms, muses
    - *Stephanecalycates*, lilies
    - *Nomendogenas* calyce & coral
    - *Spadicates*, spadica proper
    - Glumifers or calyce glumate
      - *Bambutes*,
      - *Graminates*,
      - *Cyperates*,
- The Subvascular plants have but few spiral vessels, & but little ligneous fibre within them; and they are mostly Acrogenous increasing but little in diameter after they commence to grow.
  - Ferns
    - ——— tropical ferns
    - *Filices* common ferns
    - *Botrics* differ a little
  - *Licopodes*, ground pine
  - *Equisetes*, scouring rush
  - *Marsilas*, small aquatics

The Celular plants consist of celules and they are mostly Acrogenous increasing but little in diameter after they begin to grow.
- *Mosses*, well known
- *Hepatics*, liverwort
- *Caras*, small aquatics

Irregular vegetation which we denominate Phytanomics, being Bions which resemble vegetables a little to be sure, but which have neither leaves, axis of growth, or proper roots. They are mostly *Acrogenous*, extending at their extremities but thickning not much in diameter after they commence to grow.

- *Lichens*
- *Algas*
- *Fungues*

Phytanomics

Biomycetes

BOTANY.

Of the Vegetals proper the analysis shows but little nitrogen, and often none at all. Their ligneous fibre, which however, is not always present, is somewhat analagous to the muscular fibre of animals; and, of the latter, the bones may be compared with the earthy matter, including the carbon, as well as the sulphur, silica, etc., which is found in all vegetation. It is the silica in the rind of the Endogenous plants which enables many of them to stand erect.

BIONOLOGY.

Among the different kinds of matter which belong to the earth, we find that some will unite together and thus constitute living beings; and the same we denominate *Bions.* They consist essentially of a tissue which is composed of oxygen, hydrogen, nytrogen and carbon, and which assumes a *celular* form, to a greater or less extent, in the whole of them and, in the most of them, one or more other forms such as the *vascular, fibrous* &c. These bions, a synopsy of the different classes or primary groups of which, is herewith presented, consist of *Animals, Vegetals* and *Biomycetes,* the last mentioned group being intermediate betwixt the other two, and but little above the grade of inorganized matter.

Our object, which is the only one that should be proposed in this case, has been to make as many classes as can be distinguished each from all the others of the same or a superior grade, by a tolerably short and euphonous term, taken from the Latin, or the Greek, or from the generally prevalent scientific language of the age; and, if such a term could be applied to every specie, and even variety in the whole bionic kingdom, it should be done.

The reader will excuse the English form of the words *synopsy* and *specie,* and of every other similar one in this article. It is desired also, that he will permit us to adopt the term *vegetal* instead of *plant.* The first expresses *legitimately* any kind of vegetation in the abstract; while the other refers to some *cultivated* or *particular* vegetal, and in that sense we shall frequently use it. *Vegetable,* when used as a name, most commonly implies those portions of plants which we select for food.

Of the proper animals, we have thus distinguished *forty-six* classes; of the Vegetals proper, *fifty-four;* and of the Biomycetes, *fifteen;* making one *hundred and fifteen* in the whole; and to these we shall add, other classes by means of divisions, as fast as language shall enable us to distinguish them from those we have made, in the manner above specified.

Nature often deviates from what we call system; and our business is to follow her as far as we can, and conform with her caprices, whether real or apparent, and not to attempt to mould her to ours. As all flowering plants are presumed to have a calyce and corol till the contrary appears, it becomes proper to indicate, not when these parts are present but when they are absent; and when one or both of them are absent and the circumstance does not appear in the name of the class to which such defective flower belongs it should be formally pointed out in a further description.

OF THE VEGETALS.

Class 1. The *Spadexogenas* are distinguished by their name from those which have a spadica among the Endogenas. They have no calyce and of course no corol; a circumstance, which, though indicated by the accompanying synopsy, is not so by their name, and of course it should not be considered superfluous to say so in this case. Of the class before us which are small fruticas or herbas, we have two families, the Peppers and Piperomas.—*Genus,* that barbarous term I never use.

Class 2. The *Spathexogenas* have no calyce. They cannot be put

with the last class because they seem not to have a proper spadica; nor the last with this, because that last one has no spathe.

The one before us is distinguished by its name from those which have a spathe among the Endogenas; and we have three families of them; 1st. The ***Podostema,*** the italic dress of which denotes that the plant is found in this region; and the singular form, that we are aware of but one species of it here; 2nd. The Hydrostacies; and 3d. The Lacies; and perhaps others. Mr. Lindly admits that the whole group exhibits a dubious character, and that some botanists have placed them with the Endogonas. They are small and herban.

Class 3. The *Ovarinaments*, having no proper calyce are put here, although the scales of their ament may be considered as an imperfect one They include all the known plants, except the humuly or hop which must not be seperated from the *Urticates*, and possibly some other scattering ones, whose ovaries are found in an ament. And from these the spermagymnics are excluded, because of the latter the ovaries, if such imperfect things must be called so, instead of being found in an ament, constitute the scales of one, provided, what needs not to be granted in this case, that the cone should be called so.

Of the class before us we have two orders, the *Uniplacentates*, or those whose ovary exhibits but *one* placenta, and the *Biplacentates* those which have two of them.

Order 1st. Of the *Uniplacentates* we have two fraternities, the ***Platanins*** and ***Myricans.***

Of the ***Platanins*** which are large trees, we have two families, the ***Platany*** or Button ball, and the ***Liquidambar*** or Gumtree.

Of the ***Myricans*** which are fruticas, we have the ***Myricas*** or bayberry tallow bushes, the *Comptonia* or sweet fern, and the Casuarina, which is leafless. Here it may be readily perceived that the letter *n* affixed to a family name which terminates in a vowel, or *in*, to one that does not so, denotes a *fraternity*, and that a fraternity is a group of families which resemble each other too much to be separated into subgroups of more than one family each.

Order 2nd. Of the *Biplacentates*, which are generally large trees, we have two progenies, the *Salicans* and *Betulates.*

Of the *Salicans* one fraternity, we have two families; 1st the *Salicas* or willows, 22 species according to Beck; and 2nd, the *Poples* 8 species.

Of the *Betulates* we have two fraternities, the *Betulans* and *Ostryans.*

Of the *Betulans* we have two families; 1st. The *Betulas* or birches, 8 species; and 2nd. The *Alnies* or alders, 2 species.

Of the *Ostryans* we have two families, the *Ostrya*, or ironwood, and the *Carpiny* or hop horn-beam.

Here it will be understood, that the letters *te* affixed to a family name, which terminates in a vowel, or *ite* to one that does not so, denotes a progeny; and that progeny is a group of fraternities, which resemble each other too much to be separated into subgroups of more than one fraternity each.

Class 4. Of the *Nomacalycates.* The term Acalycate implies the absence of a corol, as well as a calyce, for if a flower has but *one* of these two envelopes, that *one* must be a calyce; and if the reader will allow us to consider the spadica and spathe as *abnormal* modes of inflorescence, the prefix *Nomos* will exclude them from all acalycates; and the same term will exclude the spermagymnics, for they have a defect in the calyce and coral, so that *Nomacalycate* will imply an ordinary flower, neither spathate nor spadicate that is deprived of its calyce and coral; and of this class, which are generally small and herban, we have the same two orders of *Uniplacentates,* and *Biplacentates* which we had of the Ovarinaments.

Order 1st. Of the *Uniplacentates,* one fraternity, we have three families; Chloranthies, Ascarinas and Hedyosmies.

Order 2nd. Of the *Biplacentates,* we have *two* fraternities; 1st. The *Calitricas* one family, 3 species, which on account of their obvious affinity, to the *Halorogates,* Dr. Beck places as an annomalous family among them; and 2nd. The Saururins; and of these latter, we have two families, the Saururies and Aponogetons.

Class 5. The *Nucemoschifers,* one fraternity, are small trees or shrubs, and have no corol to their flowers, and we have two families of them, the Myristicas and Nemas or nutmeg trees.

Class 6. The *Juglandifers,* one fraternity, are large trees. They are *Apogynautophytandrous,* and have no corol to their flowers, and we have two families of them, the *Lomas,* 3 species, the black walnut, Madeira nut (exotic,) and butternut; and 2nd. The *Cayas* or hickories, 5 species, among which are the shagbarks.

Class 7. The *Depatocarpics* are mostly large trees. They are *Apogynantophytandrous,* and have no corol to their flowers, and we have two fraternities of them, the *Quercuns* and *Faguns.* The letters *s* and *m* I omit, when I find them at the end of a word.

Of the Quercuns we have two families; 1st. The *Quercues,* or oaks 23 species; and 2nd. The *Castaneas,* or chesnuts, 2 species.

Of the *Faguns* we have 2 families, the *Fagues.* or beach 2 species, and the *Corylies,* or hazle bushes, two species.

Class 8. The *Artocarpics* are large trees. They are *Apogynautophytandrous,* have no corol to their flowers; and we have several families of them; 1st. The Artocarpics or bread fruit; 2nd. The Ficues or figs; 3rd. The *Morues,* or mulberry, 2 species besides the exotic Multicaullis; 4th. The Brousonetas, or paper Mulberry; 5th. The *Maclura* or Ossage apple; 6th. The Cecropias; 7th. The Brosimies; and 8th. Even the poison Upa of Java, and perhaps others.

Class 9. The *Spermagonics* are generally herban. They are occasionally *Apogynautophytandrous,* and have no coral to their flowers; and of them we have 1st the *Polygonies,* which embraces the buckwheat and 18 other species; 2nd. The *Rumices,* or dock, sorrel &c., 9 species; 3rd. The *Reum* or ruburb, (exotic); 4th. Coccoloba, &c.

Class 10. Of the *Corticaromas*, which are shrubs and small trees, and ecorolate, we have, 1st. The *Laurues*, or sasafras and feverbush, 2 species in this country; 2nd. The Perseas; 3rd. The Litseas; 4th. The Tetranthies; 5th. The Cassythas, and perhaps other families.

Class 11. Of the *Nomasthephanics.*—The term *Astephanic* implies a calyce, because if the plant had none it would be an Acalycate; and the prefix, *Nomos*, may be considered as excluding every thing abnormal; and such we have concluded the spathe and spadica to be; and to these we must add the *Nutmeg*, *Depatc*, or burr and the *Juglandy* which are found in no other groups but the one which they are here made to indicate in the vegetable kingdom; and the same may be said of the fleshy head which is called a Fig, of the angular seeds of the spermagonics, and of the Aroma in the bark of the sassafras. They are all anomilies, so that Nomastephanic implies a plant that exhibits no peculiarity which distinguishes it from all others, except the absence of the coral; and of the class before us we have two ordars; the *Ovuledefinites*, or seeds indefinite; and the *Ovulindefinites*, or seeds indefinite; and here we have to remark that the rule for orders is precisely the same as that of classes, and two is the greatest number we can properly distinguish in this case.

Order 1st. Of the *Ovuledefinites* after many divisions and subdivisions, into *Nations*. *Tribes*, *Parties*, *Sections*, *&c.*, we have 23 progenies, or natural orders of botanists some of which, requiring no further subdivision, till they are resolved into families, may be considered as fraternities.

Order 2nd. Of the *Ovulindefinites* we have two nations; 1st. The *Unicelovaries*, ovaries with one cell, of which, after some further divisions we have 4 progenies; and 2nd. The *Multicelovaries*, ovaries with many cells of which after similar divisions we have three progenies.

Of the great class of *Nomexogenas*, we can make but two orders; the *Caliciflores*, and *Thalamifloras*; for this is the greatest number of groups which we can distinguish each from the others, in the manner above mentioned.

Order 1st. Of the *Calicifloras*, we have two nations; The *Apocarpas*, and *Syncarpas*.

Nation 1st; Of the *Apocarpas*. Following Mr. Lindley, we have two tribes; 1st. The *Calyceadherents* (to the ovary) of which after some further divisions we have three progenies, besides the excepted, *Pomifers* and *Rosates*; and 2nd. The *Calycelibers*, of which, after several more divisions, we have 5 progenies besides, &c.

Nation 2d. Of the *Syncarpas* we have the same two tribes which we had of nation 1st; and which are, 1st. The *Calyceadherents*, of which after many further divisions and subdiviions we have 19 progenies besides, &c., and 2nd. The *Calycelibers* of which after similar divisions we have 18 progenies.

Order 2d. Of the *Thalamifloras*-we have the same two nations which we had of the *Calycefloras*, and which are the *Apocarpas* and *Syncarpas*.

Nation 1st. Of the *Apocarpas*, we have two tribes; 1st. The *Apogynanders* of which we have one progeny; the *Menispermics*; and 2nd. The *Syngynanders*; of which, after many further divisions, we have 11 progenies, besides the excepted *Magnolians.*

Nation 2nd. Of the *Syncarpas* we have two tribes; 1st. The *Placentaparietals* of which after the usual divisions, we have 9 progenies; and 2nd. *Placentacentrals* (though in consequence of the disappearance of the divisions of the ovary it is sometimes only one celled) of which after many divisions and subdivisions we have 39 progenies.

Of the *Nomolostephanics*, the next largest class that we have among the flowering vegetals, we can make pursuant to our rule, but two orders; the *Coroladherents* (to the ovary) and the *Corallibers*; and here it should be borne in mind, that the corol in those cases where it appears to arise from the calyce, or ovary is attached to the same, and must be considered as extending to the receptacle beneath the ovary; so that in all cases among the *corolintegers*, when the calyce appears to adhere to the ovary, it is the corol that does so, and the calyce to the corol, and when the corol appears to arise from the ovary it adheres to the same.

The *Normalabiates* exclude the orchies whose lip is upside down.

The other classes are all quite moderate as to size.

In this arrangement there is nothing that is new in *substance*, to be sure, but much that is so in form; and with deference it is hereby submitted to the consideration of Bionologists; and we presume that every one who deserves the name, will be ingenuous enough to ask himself, whether he has a better one to offer.

System is every thing in every thing, and pre-eminently so in the subject before us; and one who contributes even but little towards a natural arrangement of any group among the great subjects of nature, deserves well of mankind.

The following article will show that the subject of which it treats is exciting interest in England as well as in this country. It will be perceived that an important source of error is pointed out, in, the difference between the estimated and actual horse power, which latter in fact, varies constantly, and to be known for any particular expedient requires the pressure in the cylinder to be known, the amount of expansion, and the number of revolutions per minute.

From the London Civil Engineer and Architect's Journal of May 1840

MARINE ENGINES.—EMPLOYMENT OF THE EXPANSIVE PRINCIPLE TO ITS FULL EXTENT IN MARINE ENGINES, WITH A SAVING OF HALF THE FUEL.

Sir—In my remarks in your Journal of last month, I dwelt at some length on the advantages to be derived from the employment of the cornish double beat valve, in marine engines, especially the facility which such afford of working the steam expansively. But it may be asked why all this talk of working expansively where there is little or nothing to expand? I would answer this question by another: why adopt a good plan by halves?

take the cornish boilers also or a suitable modification of them, and raising the steam to 35 lbs. effective, carry out the principle of expansion to its full extent; this would at once reduce the consumption of coal one half, and so double the range of our steam navigation. On such a startling proposition as this being mooted, the question naturally suggests itself, how has this so long escaped the first men of the day? That I shall not attempt to answer; it is sufficient that it has escaped them, and a very slight examination of the matter will make this evident.

Thus taking the horse power at 33,000 lbs. lifted one foot per minute with a consumption of 8 lb. of coal per hour, and this is below the average consumption, we get a duty of 23,000,000 (though 20,000,000 would be nearer the mark, especially in steamboats).

If any be disposed to assert that this is overstated as regards the Great Western and British Queen, as these vessels are said to consume above six or seven pounds per horse power per hour, I answer, the Queen's engines are 500 horse power at 15 strokes per minute, or the piston travelling through 250 feet per minute, now the pressure of steam, &c. remaining the same, the power exerted by the engine is exactly as the space through which the piston travels; but 12 strokes per minute is nearly the average number the engines make, as appears by her log, this reduces her power in the ratio of 15 to 12, and increasing the consumption of fuel per horse power in an equal ratio, makes the six or seven pounds nominally consumed equal to 8 or 9.

Whereas many of the Cornish double acting crank engines used for stamping ores, the most trying work an engine can possibly be subjected to, and where there is greatest loss by friction, are doing a duty of 50, 56, and even 60,000,000, as appears from the authenticated reports of the engineers.

Although this will not be doubted by any one who has had the opportunity of seeing the engines at work, it may suit some to doubt and even to deny the truth of these reports; so they did those of the pumping engines doing a 70 or 80,000,000 *duty*; but as 90 and even 100,000,000 is now being done under their eyes, what credence can such men expect for any statement they may in future make.

Having had occasion to visit Cornwall some three years ago on business, immediately after having completed the engines of a large vessel now on the London and Dublin station, the easy valves, the cool engine room, and almost smouldering fires of the Cornish engines, as contrasted with the stiff and heavy sides, the suffocating heat of the engine room and roaring furnaces I had just left, attracted my particular attention; and though possessing at that time no data beyond the published reports of the engineers, I saw enough to convince me of their immeese superiority, and at once set about considering how the same plan could be carried out in marine engines, a point which I hope to be now able to make clear, and the objections to which I shall endeavor to deal with in detail.

The first is the increased danger of explosion or collapse supposed to be occasioned by the great density of steam.

The second is the additional strength required in the engines to withstand steam of such density when first admitted into the cylinders.

The third is the increased weight of the boilers, and the extent of flue surface required for their successful application.

The first objection, the increased danger, I shall begin by denying "in toto," nay, it appears to me that there is absolutely increased safety: for the following reasons:

Setting aside the increased weight, &c., one boiler can be made quite as

the safety valves would have much less tendency to stick fast under the capable of supporting a pressure of 35 lbs. as another is of supporting 3 lbs., higher pressure, and their becoming a little stiff, or two or three pounds overloaded, would not be of the slightest consequence on a boiler calculated for a pressure of 35 lbs., though it would have a very dangerous tendency on one calculated for 3 lbs.

But the great argument for increased safety is this: it is an established fact, that with boilers of the usual construction, nine-tenths of the steam boat accidents occur through collapse of the overheated flues, much more than from any excessive pressure of steam in the boiler; nor is this to be wondered at if we consider how the fires are urged. Now with the Cornish boilers and a proper system of expansion, the same work can be done with half the coal, and if we consume only half the coal on the same or a greater extent of fire bar and flue surface in a given time, then it follows clearly that we have a fire of only one half the intensity, and the risk of collapse from overheated flues diminished in like proportion. But if these arguments are insufficient, then the following fact is greatly in their favor, viz: that as few if not fewer accidents occur in Cornwall where such boilers are in universal use, than in any part of the kingdom where steampower to a like extent is used; and if it be further true, as I have heard stated both in Cornwall and elsewhere, that many of the Cornish engineers will engage to keep up the boilers for ever, for the annual sum of five or six per cent on their original cost, such an argument appears to me, as it will to most practical men, to be at once perfect and conclusive.

I now come to the increased strength required in the engines, and this on examination will appear trifling. To commence then with paddle-wheels, as they remain of the same size, and are driven at the same speed, no alteration is required in them, and of course the same remark will apply to the paddle-shafts through which the power is transmitted. These being subjected to no increased strain as the average effective presssre upon the piston which takes place when the piston is half stroke, &c., and the crank is at its point of greatest torsion, is the same as in a common engine. The intermediate shaft alone with its cranks, in which the crank pins are *fast*, requires additional strength, and as this shaft is only about one-sixth the length of the two paddle shafts, and the strength of a shaft increases as the cube of its diameter, the increased weight will be trifling: next there is the top frame that carries this shaft, and the bottom frame supporting the gudgeons and colums, the strength of both must be increased, and it is as the square of their depth; next comes the piston rod, this will do as before, the piston rod of a large engine being equal to 20 times the strain that it is ever sbbjected to: the same remark will apply to the malleable iron columns supporting the top frame, as each of them is usually made of the same strength as the piston rod.

The piston must be strengthened, but the cylinder will do as before, as it is strengthened at the extremes where the greatest pressure of the steam is by its flanges, and in ordinary cases we are under the necessity of making it much stronger than necessary to ensure a sound casting, and also to support the framing attached to it; besides a cylinder of three fourths the capacity is sufficient for the same power, so here we are positive gainers in two most importent points, strength and space. The gudgeons of the cylinder of double the strength will not be stronger nor heavier than the main centres of the beam engine of the ordinary construction must necessarily be.

The points then which require increased strength are, the intermediate shaft and gudgeons, the top and bottom supporting frames, and the piston. The increased weight from this cause would not exceed 6 or 8 per cent

beyond that of the same description of engine at the ordinary pressure, and after taking this into account, the total decrease, by ading to the vibrating cylinder, would be at least 25 per cent.

I now come to the question of increased weight in the boilers, and this I shall be able to show is not nearly so great as may at first be supposed.

It will scarcely be disputed that the same thickness of plate in cylinders 6 feet diamater, the size of the exterior cylinder of the cornish boiler, will bear a water pressure at least 3 times greater than if arranged in the usual form of a steam-boat boiler; or that the former of $\frac{5}{16}$th thickness would bear without flinching a proof pressure of 60 or 70 lbs. to the square inch, while the latter would give evident signs of weakness at 20, although ever so well stayed. If then it be considered perfectly safe to work steam of 6 or 7 lbs. pressure, in a boiler which would give evident signs of weakness under a pressure of 20 lbs., surely it is equally safe to work steam of 30 or 35 lbs. in a cylinder of 6 feet diameter, and $\frac{1}{2}$ inch thick, which would bear without the slightest signs of weakness 120 lbs. on the square inch, boilers of this size and thickness being usually worked to 40, 45, and even 50 lbs. per square inch. Then 4 feet diamater, and $\frac{7}{16}$ths thickness will be ample for the internal cylinder, and to make security doubly secure, let a strong angle iron be rivetted round the internal cylinder at distances of about 2 feet apart, this would keep the cylinder or arch perfect, and so prevent the possibility of a collapse, with but trifling addition to the weight of the boilers.

Now taking equal extent of common and Cornish boilers, the former taking all stays, &c., into account, will barely average $\frac{3}{8}$ths in thickness, while the latter with its internal tube of 18 inch diamater, and $\frac{5}{12}$ths inches thickness, would average about $\frac{1}{2}$ inch. This makes their respective weights at 3 to 4, but in order to the successful application of slow combustion we require addition flue surface, so take 3 to 5 as the ratio of the weight of common and Cornish engines and water for the same power, the extra space required for the boilers being much more than compensated, by the small space occupied by the vibrating engine.

But to go more minutely into the matter, the weight of a Cornish boiler and water of the size and thickness named, and 35 feet in length, is = 24 tons, exposing a surface 938 feet: eight such boilers might be easily set in the space allowed for the Queen's boilers, now $8 \times 24 = 192$ tons, as the weight of the boilers, and allowing 50 tons for setting and clothing, we have $192 + 50 = 242$ tons, total weight of the boilers, and setting, &c.; $938 \times 8 = 7504 \div 500 = 15$ feet surface per horse power, being one-half more than the usual allowance without increasing the weight of the boiler at all, or occupying more space in the vessel.

But allowing that we have increased the weight of the boilers in the ratio of 35, let us take the British Queen as the subject of comparison.

The total weight of her engines and boilers is 500 tons, and of this 220 may go in round numbers for boilers and water, and $3 : 5 : : 220 : 366$, and $500 - 220 + 366$ gives 664 —and less 64 tons being the decreased weight of the vibrating engnie = 600 tons, as the weight of her engines and water on the Cornish plan.

The accoum would then stand thus on the present plan,

Engines and boilers, - - - - - - - -	500 tons
20 days fuel, - - - - - - - - -	750
Total, - -	1250

On the Cornish plan,

Engines and boilers, - - - - - - - -	600
20 days fuel, - - - - - - - -	375
Total, - -	975

Showing a capacity for 285 tons more cargo, and a saving of 375 tons of coal.

Though some may consider these figures as exaggerated without being able to assign any reason to themselves or others, save that the plan is impossible. Those who have examined the subject will assuredly blame me for not having gone far enough; and there is another class of well meaning men among engineers and others, who have imbibed such a reverence for the name of Watt, that they almost consider any deviation from the plans he followed, or improvements upon the state in which he left the steam engine, to be an insult to his memory, and a deduction from his fair fame; but my admiration of Watt is as great as any man's can be; I am proud of him as a countryman, and honor him as a great man, and so have endeavored to add a stone to the monument he has raised, by carrying out a principle which in his third patent of 1782, he distinctly propounded, and of the advantage of which that great man seems to have been fully aware, though he lived not to see it carried into effect.

If then I am borne out in these statements, and to disprove the main point, the grert increase of duty by expansive working is altogether impossible; and the others I think I have succeeded in making tolerably clear, though on some points as the weight of the present boilers and water of the British Queen, I may have made some slight mistake not amounting to a few tons either way, having assumed it from comparison with others, and not stated it from actual knowledge, yet on the other hand I have underrated the saving of fuel, and allowed quite enough for the increased weight of the boilers, as there is less due to the great extent of surface than is supposed, the expansion being the point where the power is gained; and however the proposition of adopting steam of increased density may be cavilled at, to the priniple of expansive working and slow combustion we must come at last, and by adopting them to their full extent, which I think I have shown to be equa'ly safe and perfectly practical. The Cape of Good Hope is as much withln our reach as New York now is, and a speedy and sure passage open to our Indian and Australian empires.

Such then being the case, are we content to allow our preconceived ideas to supersede our better judgment, and go on loading our vessels with unnecessary coal, and thus uselessly consuming our most valuable mineral—limit at the same time the range of our steam navigation, and the civilization of the world at large; or do our engineers mean to allow that they cannot make a boiler safe under a pressure of 35 lbs., or that one of the thickness and diameter that I have proposed would not be perfectly safe under that pressrue. If they allow neither of these propositions, then the sooner the subject is seriously taken up the better, as every boat now fitting with the usual beam or side lever, engines, (and many of the splendid mail packets are being thus fitted,) is incapable of being afterwards altered, so as to work expansively, as though the boilers may be altered, the beams, &c., would never stand the increased pressure.

Before concluding, perhaps I may be allowed to correct an omission in my last paper. It is a favorite remark of naval men, "get as extended a hold of the vessel as possible." Now it has often struck me, not only in those vessels I have myself been engaged in, but in every one I have had the opportunity of seeing, that this very reasonable remark is not only not complied with, but that the power is positively brought to bear on the wrong place. Thus no attempt that I have seen has been made to lay hold of the vessel fore and aft, in a line with the centre of the paddle shaft, but the framing is stayed sideways, or at best slightly supported by the most contiguous deck beams, and the horizontal strain of the propelling power acting at the bear

ings of the shaft, the engine frame is thus used as a lever to wrench the under frame of the vessel as it were assunder, and an action is thus created tending materially to weaken the vessel and increase the unpleasant vibration, to remedy this defect, and at the same time to prevent the framing and joints of the engine from breaking, uncommonly heavy bed plates have been resorted to; those on board the British Queen, amounting at least to 23 tons; now without entering into a discussion on the point, what I propose is this, let a strong flat bar of wrought iron be carried fore and aft opposite each engine, gradually tapering away, and running in towards either side of the vessel, being at the same time securely bolted through ten or twelve of the deck beams, on the end of this next the engine, let there be a strong joint and a similar one on the engine frame joined by a strong connecting rod, this would allow sufficient play, and at the same time, if I may use the expression, give the porter a hold of his load by the right place.

To conclude, if it be considered that I have not gone sufficiently into detail completely to prove every point I have advanced, my answer is, I have considerably underrated the gain, and overrated the loss, thus rendering minute calculation of strength and weight uncalled for; besides such would have been of no value to any one not intimately acquainted with the subject, and practical men can examine it for themselves.

My object has been to keep the main points of the argument in view, and to make it intelligible to all classes of your readers, and in this I hope I have succeeded, and should you or any of your readers be able to furnish me with the exact weight of the boilers of the British Queen, and the space they occupy, with any further particulars, I will in a future number enter more minutely into the subject, and illustrate by a few sketches my ideas of how the boilers on the Cornish plan should be set and clothed, and where the extent of surface I have spoken of is obtained; having no doubt that I shall be able to establish every point that I have advanced, bearing on the increased safety and economy of the plan proposed, and at no distant period see it carried into successful operation on a scale commensurate with the importance of the undertaking, and the vital influence which such an improvement would have on our political and commercial relation with all parts of the world.

Pimlico, April 4, 1840. A. S.

ON BLASTING LIMESTONE ROCK.—*Some account of blasting the white limestone, in the county of Antrim, in Ireland.* By William Bald, F.R.S.E., M.R.I.A., &c. Read before the Institution of Civil Engineers.

It becomes necessary to make a few short observations which may perhaps be interesting to the scientific engineer. Along the north coast of Ireland from the Bay of Belfast to Lough Foyle, the country consists of white limestone; columnar basalt, and some conglomerate sandstone; but the hill of Carey consists of mica slate; and is of the same formation as the Mull of Cantire, a part of the coast of Scotland lying opposite. The geologist can here easily trace the connecting link in the formation, which joins the two countries, although a chanel 90 fathems deep seperates them. Numerous whin dykes intersect the strata along this part of the Irish shore, they run nearly parallel to each other in some cases, and are very remarkable in their structure.

The study of the peculiar qualities of the respective rocks and strata, and their position and inclination, will enable the engineer to work them in a more scientific manner. And in the construction of harbours, lighthouses

lines of navigation, drainage, roads, &c., &c., an intimate acquaintance with the component parts of the rocks, will enable him to select those best suited to resist the action of time, whether they be placed under the dominion of the deep, exposed to the ravages of the pholas, or subject to perhaps the more wasting influence of the atmosphere; by such studies his skill will be alike visible in the selection of the best material for the repaving of even a common road, as it will be for that of the most splendid edifice destined to survive ages.

In constructing the Antrim coast road it became necessary to cut through extensive and high masses of white limestone; one of the sea cliffs in the Little Deer Park, near Glenarm Town, extendnd to a length of nearly one thousand yards, rising from twenty feet to about two hundred in height, washed at its base by a deep sea, and entirely exposed to the run of the ocean in the north channel.

Above the white limestone is situate the columnar basalt, but no part of the road was cut through this last mentioned rock. The white limestone in Antrim differs from the chalk in England, in being more indurated, while in other respects it is similar to it in the quantities of flint it contains. This rock is close and fine in its texture, but it is deeply fissured in many directions; the scull veins it exhibits are extremely curious.* The inclinations of the limestone strata on this part of the coast does not in general exceed 15° dipping into the land. Under the limerock strata lies the brownish red coloured sandstone.

In blasting down those lofty cliffs of white limestone, the borings were always made into the toe of the rocks, and were so arranged that the line of least resistance should not be in the direction of the line of boring. Hundreds of tons of rock frequently rested on a base of a few superficial feet, which being blasted away, the cliff above tumbled down. The patent safety fuse was used, and which was attended with the most beneficial results, copper tubes, for putting in the charges, and also copper needles.

During three years operations not a man was lost, although upwards of one hundred thousand tons of limestone were blasted down upon less than one mile of the road.

The following are the results of a few experiments made upon loose detached blocks of white limestone at Glenarm, Little Deer Park.

	Cubic feet in each block.	*Quantity of powder used.*	*Cubic feet for each ounce of powder used.*
Block No. 1.	165	12oz	1378 ft.
2.	180	12 oz	1500
3.	540	38 oz	1421
4.	864	64 oz	1350

From the above experiments it took one ounce of gunpowder to rend asunder 14·12 cubic feet of the white limestone when in blocks. And from experiments made on the solid loose whinstone blocks, it took about one ounce of gunpowder to blast asunder 11·75 cubic feet.

Three experiments assigned the specific gravity of the white limestone at 2,747, 2,769, 2,763; and the whinstone or basalt at 3,200, being about 13 cubic feet of white limestone to the ton, and 11·20 cubic feet of the whinstone to the ton.

* The grey limestone with which the light-house of Clare island is built, is much traversed by scull veins, and water enters them during severe rain storms.

TABLE OF THE WORKING PROCEEDINGS.

	Depth of boring.	*Quantity of powder.*
An auger of 1¼ inch diameter.	15 inches deep.	6 inches.
ditto 1½ ditto	26 ditto	8 ditto
ditto 1⅞ ditto	30 ditto	9 ditto
ditto 1⅞ ditto	36 ditto	12 ditto
ditto 1⅞ ditto	48 ditto	17 ditto
ditto 2 ditto	5 feet	20 ditto
ditto 2 ditto	6 feet	27 ditto

The above table exhibits the diameter of the auger or jumper used, the depth sunk, and the number of inches of gunpowder put in. (One pound of gunpowder occupies 30 cubic inches).

The force of the explosion of gunpowder is assumed to be as the cube of the length of the line of least resistance, thus if one ounce of gunpowder will open a distance of one foot of rock, the table would run thus:—

Line of least resistance.	*Charge of powder exclusive of priming.*
If 1 foot of rock requires - -	1 oucce
2 feet would require - -	8 ditto
3 - - - -	27 ditto
4 - - - -	64 ditto
5 - - - -	125 ditto
6 - - - -	216 ditto
7 - - - -	343 ditto
8 - - - -	512 ditto
9 - - - -	729 ditto
10 - - - -	1000 ditto

I am aware there is much difficulty in knowing exactly where the line of least resistance is, because the rock may be fissured, or some bed or opening may be near to the line bored, and this is the case where the rocks are stratified; but the hypogene rocks, such as granite and syenite, lying in large solid compact masses unstratified will be different, and these rules may be usefully applied. In blasting assunder loose detached blocks, a much greater quantity of material will be blown assunder by the same quantity of gunpowder than of rocks lying in close connected beds.

It is always desirable to work the rock out by the dip of the inclination of the strata, or as the quarrymen call it the going way of the rock.

In the white limestone quarries lying in the high ground north of the town of Belfast, where the limestone is quarried for building and agricultural purposes, and also for export; two men will quarry out at an average from eight to ten tons per day, the augers or jumpers generally used are 1⅞ inches, and two inches diameter; and the induration of the white limestone may be estimated when two men will bore one foot deep in half an hour; they generally put in about three inches of powder for 15 inches deep, and 6 inches for about two feet deep; the expense for quarrying is about from five pence to sixpence per ton. There are nearly 13 cubic feet of the white limestone to the ton, which is at the rate of nearly about one shilling per cubic yard. This white limestone is much esteemed in Glasgow and all the towns on the Clyde, where it sells for five shillings per ton—but the quarrying works near Belfast are carried on in a very limited manner, or rather on a very small scale.

Numerous experiments made by military engieneers, assign the force of the explosion of gunpowder to be as the cube of the length of the line of least resistance. Vauban and Belidor, both of them excellent mathematicians, and also possessing great practical skill, ingenuity and experience, investigated this subject, doubtless more particularly with a view to the op-

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erations of war, than to those of the works of the civil engineer. The law of the explosive force of gunpowder remains the same in all the various forms it may be applied to matter, whether in blasting out of rock or earth, or the destruction of the masonry of fortifications by blowing them up, or laying in ruins bridges built over large and deep rivers to arrest the progress of hostile armies.

The total cubical contents of the four blocks of limestone given above, amounted to 1749 cubic feet, and the quantity of powder used 126 ounces, being at the rate of 1.94 ounces for each cubic yard blasted asunder. But if the rate per cubic yard be deducted from the quantity of powder expended on each block, then the following will be the results obtained from the four experiments.

165 cubic feet was blasted asunder by 12 ounces of gunpowder, which is at the rate of 1·96 ounces of powder for each cubic yard.

180 cubic feet was blasted asunder by 12 ounces of gunpowder, which is at the rate of 1·80 ounces of powder for each cubic yard.

540 cubic feet was blasted asunder by 38 ounces of gunpowder, which is at the rate of 1·90 ounces of powder for each cubic yard.

8 64 cubic feet was blasted assunder by 64 ounces of gunpowder, which is at the rate of 2 ounces of powder for each cubic yard.

Therefore in the large loose limestone blocks about two ounces of gunpowder may be taken as the expenditure being necessary to blast out each cubic yard. The four blocks on which these experiments were made, were not at all cubical, although the one which contained 540 cubic feet was nearly so. From the above results I beg to submit some calculations regarding the force of the explosion of gunpowder, being as the cube of the length of the line of least resistance.

We are in possession of the quantity of gunpower used in blasting the 4 blocks, and also of the solid feet contained in each of them. Extracting therefore the cubic root of the cubical contents of each block, we shall then have their masses all in cubical form as follows:

Cubic feet in each block.		*Side of the cube.*
$\sqrt[3]{165}$	- -	5·484
$\sqrt[3]{180}$	- -	5·646
$\sqrt[3]{540}$	- -	8·143
$\sqrt[3]{864}$	- -	9·524

Taking the length of the line of least resistance at each of thsee cubes to be equal to the distance from the centre to the nearest point on the surface, or equal to half the side of the cube, then the following will be the lengths in feet of the lines of least resistance.

In cube No. 1 — 2·742 feet.
No. 2 — 2·823
No. 3 — 4·071
No. 4 — 4·762.

The quantities of gunpowder consumed to blast asunder a line of least resistance, of

2·742	feet was	12 ounces,	165	cubic feet blasted asunder.
2·823	-	12 ditto,	180	ditto.
4·071	-	38 ditto,	540	ditto.
4·762	-	64 ditto,	864	ditto.

If 165 cubic feet be blasted asunder by 12 ounces of gunpowder, the line of least resistance in that mass, if in cubical form, will be

$$\sqrt[3]{165} = 2.742 \text{ feet.}$$

Then the line of least resistance for one foot in cubical form will be equal

to 8 cubic feet. Then if 165 cubic feet with a line of resistance of 2·742 feet require 12 ounces of gunpowder to open it, then 8 cubic feet with a line of resistance of one foot will require 0·582 ounces of gunpowder to open it asunder.

The following are the quantities of gunpowder required to open one foot of least resistance through the white limestone, as determined by the blasting of the four blocks.

Cubic feet in each block - -	165	180	540	864
Quantity of powder used to rend it asunder, in *ounces* - - -	12	12	33	64
Cubic feet opened by the line of resistance of one foot - -	8	8	8	8
Quantity of powder required to open the line of least resistance of one foot, in *ounces*, - - -	0·582	0·533	0·563	0·593

Mean 0·568

Apply the rule of the cube of the length of the line of least resistance, and working with the element just obtained from the four experiments, to open asunder the line of least resistance of one foot.

No. 1—Then the scale of the length of the line of least resistance in No. 1, $2{\cdot}742^3$ feet multiplied by 0·582 ounces, the quantity of powder to open one foot will be $2.742^3 = 20{\cdot}62 \times {\cdot}582 = 12$ ounces.

No. 2—For a line of least resistance of 2·823 feet will be 11·95 ounces, $2{\cdot}823^3 = 22{\cdot}42 \times {\cdot}533 = 11{\cdot}95$ ounces.

No. 3—For a line of least resistance of 4·071 feet, will be 37·97 ounces, $4{\cdot}071^3 = 67{\cdot}45 \times {\cdot}563 = 37{\cdot}97$ ounces.

No. 4—For a line of least resistance of 4·762 feet, will be 64 ounces, $4{\cdot}762^3 = 107{\cdot}983 \times 593 = 64$ ounces.

It is therefore, clear from these experiments made that the force of the explosion of gunpowder is as the cube of the length of the line of least resistance. Taking the mean quantity of gunpowder obtained from the four experiments to open asunder a line of resistance of one foot, and which is 0·568 ounces. The following will be the results calculated according to the cube of the length of the line of least resistance.

$2{\cdot}742^3 = 20{\cdot}62 \times 0{\cdot}568 = 11{\cdot}71$ oz. $= 165$ cubic feet.
$2{\cdot}823^3 = 22{\cdot}42 \times 0{\cdot}568 = 12{\cdot}73$ oz. $= 180$
$4{\cdot}071^3 = 67{\cdot}45 \times 0{\cdot}568 = 38{\cdot}31$ oz. $= 540$
$4{\cdot}762^3 = 107{\cdot}983 \times 0{\cdot}568 = 61{\cdot}33$ oz. $= 864$

In having described the mode of blasting the white limestone on the Antrim coast road in the north of Ireland. It may be useful as well as interesting to the engineer to describe its qualities, and to what extent it may be employed in the construction of works.

In treating of the nature of any kind of material to be employed in building, the first consideration is its character, to resist decomposition whether placed in the open air exposed to the full action of the atmosphere, or buried in the earth, or entombed in the deep. Its induration and compactness of structure, the absence of figures, the mass it can be had in, and the facility of working or tooling it into form.

The white limestone on the Antrim coast road lies in beds dipping slightly to the plane; it is generally quite white, but sometimes it is of a yellowish tint; it is traversed by very small veins of calcareous spar, but the most remarkable feature is the quantity of flints it contains, they are dry, grey and black; the thickness of the beds of the white limestone is very singular, being sometimes more than 30 feet.

This white limestone is not good for building, because it moulders by

exposure to the atmosphere, it is not therefore generally used in any public building, although it might be used in filling up the interior parts of walls: it is inferior for road metal, being tender and wearing quickly; it can be procured in large masses, when reduced to pieces containing six, twelve and eighteen cubical inches, it breaks into irregular fragments with sharp edges.

The white limestone when placed under the sea is particularly subject to the ravages of the pholas, and is therefore unsuitable to be employed in the construction of marine works, such as harbors or breakwaters, &c., it is however a valuable material for making lime for building, and for agricultural purposes. In our quarrying operations we rarely found in it shell remains.

In quarrying it out in large masses, the blocks sometimes had what the workmen call a lean and a full bed; the lean bed being less than an angle of 90°, and the full bed more than 90°.

The white limestone can be split with plug and feather, or pooled by wedges; if the stratification be in thin beds, it opens across with a very rugged and irregular face, but if very solid and compact, and the beds of great thickness, it will open more evenly and equal in the face. It dresses readily with the hammer, and can be wrought and hewn into any form. I am however of opinion, that the white limestone of the county of Antrim, should not be used in constructing any work requiring durability, because it is a rock liable to decomposition, when exposed to the atmosphere.

I have already, in the paper on blasting the white limestone, alluded to the small fissrues which traverse that rock, and which also traverse the blue and grey limestone of Ireland, and which the stone cutters call scull vein doublers, on account of their exact resemblance to the sutures in the human scull.

In concluding, I beg to mention that there are several species of the Pholas Lamarh in his natural history, mentions the Pholade Dactyle or Pholas Dactylus, as being very prevalent on the coast of France, and also inhabiting the shores of the British seas. I have given a sketch of the Pholas Dactylus, and I beg to present to the Institution a very beautiful specimen of this kind, from which the sketch has been made, and which specimen I have accidentally obtained in London. There is another species called the Pholade Scrabrelle, or Pholas Candida, which inhabits the European seas, and a very small kind called by the French Saxicave Ridee, Saxicava Rugosa. It is quite foreign to the object of this paper, to enter into any thing like giving an account of the various kinds of Pholas, or their habits; it is quite sufficient to the engineer to know that every description of calcareous rock, when placed under the sea, is subject to be perforated by those bivalves; indeed every rock upon which acids act are subject to be destroyed by them, and it consequently has been conjectured that they possess the power of producing an acid that decomposes the rock containing calcareous matter; on the other hand some maintain this is not the case, because the acid would also decompose the shell that covers them. Mr. Lonsdale, of the Geological Society, mentioned to me that some marine works constructed at Plymouth were much injured by the ravages of the Pholas. Beds of calcarous rock of several feet in thickness, in the Frith of Forth have been entirely destroyed by the Pholas.

It will be seen that the shell of the Pholas Dactylus, presented to the Institution, is very tender and delicate; from the extreme fragile nature of the shell it would not be supposed capable of destroying indurated marble. The external surface of the shell is rough, and radiated transversely and longitudinally in a most beautiful manner by curved lines of a high order; an attentive study of the mere lined surface of the shell cannot fail to be instruc-

tive even to the man of science, and worthy to be contemplated and examined by all those engaged in the works of art and taste. The marine engineer may derive instruction from the parabolic curves delineated, and traced out by the hand of nature on the Pholas shell, in assisting him in giving the best shape to the slopes of breakwaters, and harbors constructed in the deep sea, and exposed to the run or momentum of the ocean. The curved radiation or fluting on the shell cannot fail to attract the architect engaged in the works of design and taste. It ought not to be forgotten what struck Watt in examining the joints in the tail of a lobster; nor of Smeaton in looking at the form of an oak tree; nor the falling of an apple which gave the impulse to the genius of a man justly the glory of our island; and whose name stands recorded with the proudest triumphs in the loftiest branches of science that has yet adorned the efforts of human ingenuity.

William Bald.

BRITISH AND AMERICAN STEAM NAVIGATION COMPANY'S SHIP PRESIDENT.

This ship will leave Liverpool for New York on the 1st of August, and is undoubtedly the largest and most splendid steam ship that has ever been built. She measures 350 tons larger than the British Queen, with which ship she is to keep up a monthly communication between this port London, and Liverpool, sailing alternately the first of each month. The President will depart regularly from Liverpool, and the British Queen from London.

The annexed particulars will give the public some idea of her arrangements, which are on a scale to reflect the highest credit to the enterprising company owning her.

The accommodations for passengers in this magnificient ship are of the very first order, combining the advantages of ample light, air and space with the richest and most elegant decoration.

The upper deck consists of a saloon or dining room 31 feet wide by 28 feet long, communicating by a double entrance, with a wide and lofty corridor, which reaches entirely to the after part of the ship. On each side the corridor are spacious state rooms for first class passengers, excellently lighted and ventilated, not entered as they usually are, immediately from the public walk, but from seperate passages, each containing a large window. At the other end of this deck is a commodious room expressly for the ladies room, and a large state room for a private family.

The style of decoration of the whole is the Tudor Gothic of the 13th and 14 centuries.

On entering the dining saloon from two lobbies, the appearance of it is very quiet and chaste. The panneling on all sides consists of Gothic work, richly carved, and painted to imitate new oak highly polished, the ground of the pannels being of a simple neat color. The furniture is all of real English Oak, highly polished, with Gothic carving, and covered with embossed Utrecht velvet of a rich brown color. The dining tables are four in number, placed lengthwise of the ship, and when fully extended, will accommodate 120 persons to dine.

The sofas are placed along the sides of the room and at each of the four windows. There are four handsome gothic sideboards, neatly fitted up with the portraits of a "President" (Washington being one) over each. The whole, with the help of several mirrors, has an exceedingly light and elegant effect.

The ladies cabin, is also a very neat and elegant room, being richly ornamented in the Gothic style, in colors of white and gold, and the walls

hung with a pleasing imitation of tapestry, of a grey color, having the English rose and the American star in neighborly proximity.

The corridor, however, is the part which for richness of effect and merit of design, exceeds all which we have hitherto seen on board any ship, resembling rather a gallery in a nobleman's mansion.

The ceiling, the lantern lights, the walls and the doors, are of the richest carved Gothic work, painted in imitation of old oak wainscoting, and on both sides, the walls are hung with paintings (in imitation of ancient tapestry) on a rich crimson ground representing the history and achievements of the great Columbus, comprising all the most important events of his life, among which, and not the least conspicuous, is his discovery of America. These subjects are extremely well designed and painted, especailly when the difficulty of the imitation of needlework is considered, and are all original compositions.

It should be remarked that the adaptation of the Gothic architecture of his time, and the story of Columbus, to a ship named the President and designed for the American trade, is in excellent taste.

We would call attention also to the manner in which the introduction of light and air to the lower deck is made ornamental to the corridor itself, by the construction of a parterre of flowers, and an exceedingly light and neat spiral staircase, which is the medium of communication between the two decks.

The lower deck is laid out simply into spacious light and airy passages. and state rooms, in which every contrivance for comfort which art can suggest, has been attended to. The whole will accommodate 116 to 120 persons, and all so well, that we should be puzzled which berth to give the preference to.

The whole of the fittings up, decorations and furniture, are designed and executed by Mr. B. H. Simpson, 456 West Strand London, who also fitted up the British Queen.

The figure head of the President will be a full length likeness of General Washington; and a capital likeness it is. It will be gilt.

The following is a list of the subjects introduced in the tapestry:

No. 1. A. D. 1470.—Columbus selling maps and charts at Lisbon, for the support of his family and aged father at Genoa.

No. 2. A. D. 1470.—Columbus contemplating his enterprise, is kindled into enthusiasm by considering himself to be the person alluded to in holy writ, who is to carry the gospel into new lands.

No. 3. A. D. 1484.—Columbus begging bread and water for his child at the Franciscan Convent of St. Rabida; Juan Perez Marcheza passing by, is much struck by his appearance.

No. 4. A. D. 1484.—The conference at La Rabida, at which Juan Perez Marcheza and the Physician Garcia Fernandez, are struck by the grandeur of his views.

No. 5. A. D. 1492.—On Friday, 3d. August, 1492, Columbus set sail as Admiral of the seas, and the land he expected to discover. On the 11th October, Columbus stood on the stern of his vessel, when he espied land at 2 o'clock in the morning. The foremost then fired a signal.

No. 6. A. D. 1492.—Columbus landed and gave thanks to heaven for the success of his enterprise. At dawn, on the 12th October, he landed in the new world, at Guanahani or St. Salvador, one of the Bahama Islands, when the most mutinous and rebellious of his crew thronged around him and embraced his feet. The naked and painted natives regarded the white men as visitors from the skies.

No. 7. A. D. 1492.—Columbus entering Barcelona in triumph. In

his journey through Spain he received princely honors all the way to Barcelona where the Court then was. Several natives returned with him.

No. 8. A. D. 1493—Columbus received at Court by Ferdinand and Isabella, who rose as he approached, and raised him as he kneeled to kiss their hands.

No. 9. A. D. 1500.—Columbus arrested. Notwithstanding his great successes, his enemies at home persuaded the king to supersede him, and Francis Baradilla was sent to bring him back in chains.

No. 10. A. D. 1500—Columbus's arrival at Cadiz, a prisoner, chained—which event caused so universal a burst of indignation throughout Spain, as to compel Ferdinand to disclaim all knowledge or share in the disgraceful transaction.

Columbus born 1446, at Genoa; died, aged 61 years, in neglect and poverty.

"Thus ended," says the Historian, "a noble and glorious career, inseparably connected with the records of the injustice and ingratitude of kings."

PASSAGE OF RAILWAY TRAINS OVER THE MENAI BRIDGE.

From the Commissioners Report on the proposed Railway Communication between London and Dublin.

From Penman Mawr the lines (of Mr. George Stephenson and Mr. Giles) follow a course in which there is not any essential difference until they reach the corner of Penrhyn Park.

Here Mr. Stephenson proposed to pass under the turnpike road; then over the river Ogwen, by a bridge 37 feet high, with embanked approaches, and afterwards through a cutting five-eights of a mile long, and 45 feet deep.

The line then crosses the river Cagen and the valley through whch it runs by a short, viaduct, and an embankment 350 yards long, the extreme height of the former being 75 feet; this brings it to the ridge on the east side of Bangor. By cutting a tunnel 490 yards in length through this ridge the line would open on the Bangor valley, and pass Castle-street by a viaduct 35 feet high, and 125 feet long. It would then cross the valley, by an embankment and viaduct of a quarter of a mile in length, and of the extreme height of 70 feet. Mr. Stephenson proposes to pass through the hill of Penrhalt by cutting 1,000 yards in length and 17 feet in mean depth; and curving, with a moderate radius, to cross under the turnpike road and join the Menai bridge.

Mr. Giles, on proceeding from Penrhyn Park, recommends a more direct course than that of Mr. Stephenson, so as to bring his line nearly opposite to the end of the Menai bridge; but in adopting this plan, he would have to encounter very formidable difficulties, in the construction of two viaducts, and two tunnels, one of the latter being one mile and a quarter, and the other three quarters of a mile in length.

The passage of the Menai bridge is the next point of importance. It has been supposed that this would have presented an insuperable obstacle to the lines of Messrs. Stevenson and Giles, but neither of these gentlemen proposes to cross the bridge with locomotive engines; the former suggesting that the railway carriages may be drawn over by horses, and the latter by a stationary engine.

There seems to be no objection to either of these plans, and the loss of time consequent upon them would probably not exceed one quarter of an hour.

The following observations will show the sufficiency of the Menai bridge to sustain the weight of any number of railway-carriages that may be required to pass over it.

In the first place, as far as regards the mode of passage, no important difficulty can be foreseen; the only question therefore is one of strength.

The weight of a railway passenger carriage, with its load, is commonly estimated at about 5 tons, and the length occupied by each carriage, from one connecting pin to another, may be taken at 22 feet, when several carriages are in connection. This would give a pressure of only ·23 of a ton per lineal foot on the length of the bridge, supposing the platform to be wholly filled with such carriages.

Let us now see what weight the bridge is capable of sustaining.

It appears from the statement of Mr. Provis,* who was the resident engineer, during the erection of this splendid structure, that the suspended part between the piers consists—

	Tons.	cwt.
Of 16 main chains, including connecting plates, screws, bolts, &c., weighing - - - - - - - -	394	5
Of transverse ties, - - - - - - - -	3	16½
And of suspended rods, platforms, &c., - - - -	245	13½
The total weight being, - - - -	643	15

The distance between the points of suspension is 579 feet 10½ inches, and the deflection 43 feet. With these data the tension, in terms of the weight may be readily computed, from the properties of the catenary curve! but it will perhaps be more satisfactory to derive it from the actual experiments of Mr. Rhodes, who superintended the erection of the chains, and who found, practically, the tension to amount to 1·7 times the weight. This makes the tension on the supporting chains from the weight of the structure alone, to amount to 1,094 tons.

Now to sustain this tension, we have a sectional area in the 16 chains of 260 square inches, which according to Mr. Barlow's experiments, made on the chain-cable testing machine at Woolwich, are capable of sustaining 2,600 tons, without injury to the elastic force of the iron, namely ten tons per square inch, the ultimate strength being 25 tons per square inch.†

	Tons.
If then, from the absolute strength of the chains	2,600
We deduct the strain due to the weight of the bridge, - - - - - - - -	1,094
There remains a surplus strength of	1,506 tons

which is competent, therefore, to sustain a uniform load (allowing the tension to be 1·7 times the weight) of $\frac{1506}{1\cdot7}$ or 886 tons. Now if the bridge were covered with loaded railway carriages on both sides, it would only be equivalent to 265 tons, leaving still a surplus strength of 621 tons. The objections, therefore, that have been raised respecting the capability of the bridge to bear the weight of the railway carriages which it might be required to support, must be considered as utterly groundless.

Mr. Stephenson proposes to establish a station at each end of the bridge, where the locomotive engines would be kept in readiness to be attached to the trains.

* See Mr. Provis's valuable work on the Construction of the Menai bridge.

† Mr. Barlow's Report to the Directors of the London and Birmingham railway.